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Research on test ofalkali-resistant glass fibre enhanced seawater coral aggregate concrete

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Abstract. It is proposed in the 13th five-year plan that reefs of the south China sea should be constructed. In the paper, an innovative thinking was proposed for the first time in order to realize local material acquisition in island construction and life dependence on sea, namely alkali-resistant glass fibre is mixed in coralaggregate concrete as reinforcing material. The glass fibre is characterized by low price, low hardness, good dispersibility and convenient construction. Reliable guarantee is provided for widely applying the material in future projects. In the paper, an orthogonal test method is firstly applied to determine the mix proportion of grade C50 coral aggregate concrete. Then, the design plan ofmix proportion of alkali-resistant glass fibre enhanced seawater coral aggregate concrete is determined. Finally, the influence law of alkali-resistant glass fibre dosageon tensile compressiveflexture strength of seawatercoralaggregate concrete is made clear.

1. Introduction

The oceans are becoming more and more important in current globalization era. As a major maritime power, China has important maritime economic interests, which also encounters serious maritime security situation at the same time. It is necessary to safeguard maritime rights and interests. There are serious territorial dispute problems in the south China sea, and there is an urgent need for construction of islands and reefs in the south China sea currently. The ocean islands are characterized by limited supplies and traffic inconvenience. It is very difficult to obtain traditional building materials. On the basis, exploitation and utilization of coral concrete have extremely important significance for ocean reef engineering construction. However, since coral concrete is characterized by low compressive strength, tensile strength andelasticitymodulus, etc., and it is limited in the development and application fields. Meanwhile, steel corrosion can be accelerated due to existence of chlorine. However, coral aggregate derives from marine environment. Its own chlorine salt content is higher, therefore, it is incapable to adopt steel, steel fiber and similar materials for studying coral concrete enhancement.

In the paper, the research on alkali-resistant glass fibre enhanced seawater coral aggregate concrete is described as follows:

2. Design of mix proportion of C50 seawatercoralaggregate concrete and research on its basic mechanical property

In the paper, the influence on the strength of C50 seawater coral aggregate concrete is analyzed aiming at the orthogonal test method of four factors and three levels (factors include cement, volume sand ratio, and coarse aggregate and net duty of water), thereby obtaining C50 seawater coral aggregate concrete with excellent performance.

2.1 Experimental materials

Coral aggregate belongs to binder less loose coral clastic sediment. There are a lot of gaps. Coral aggregate belongs to natural lightweight aggregate according to concrete aggregate general classification in China. Performance of coral particles was tested according to ‘Light aggregate and its test method’ (GB/T17431.2-2010). In the paper, coral gravel is used as the coarse aggregate. Coral sandis used as fine aggregate, and cement is used as anti-sulfate cement (PO grade 42.5 sulfuric acid silicate cement). Manually configured seawater is used for mixing (all materials are configured according to seawater indicators).

2.2 Test design and results

Four-factor and three-level method was adopted in order to design the mix proportion of C50 and coral aggregate concrete. Four factors were designed, respectively including the follows: coarse aggregate dosage, volume sand ratio, purified water dosage and cement dosage. The orthogonal test design table is shown in table 1.

Table 1. Orthogonal testdesign

No.	Coarse aggregate/($kg{\bullet}m^{-3}$)	Net duty of water /($kg{\bullet}m^{-3}$)	Volume sand ratio/%	Cement /($kg{\bullet}m^{-3}$)	Strength/MPa
A1	680	190	41	430	50.02
A2	680	200	45	480	53.07
A3	680	210	43	450	52.79
A4	710	190	45	450	56.70
A5	710	200	43	430	51.84
A6	710	210	41	480	54.79
A7	740	190	43	480	55.11
A8	740	200	41	450	56.76
A9	740	210	45	430	52.15

In the paper, it was found that the influence of cement dosageonconcrete strength was far greater than other factors by significance analysis on mean value an variance of orthogonal test results. The influence of coarse aggregate dosage also had more significant influence in comparison. The influence on net duty of water is smaller. It should be noted that the feeding order should be focused during concrete mixing due to feeding and water absorption function of coral aggregate.

The mix proportion of C50 seawater coral aggregate concrete concluded in the paper is shown as follows: cement 450kg/m3, fine aggregate (coral sand) 660kg/m3, coarse aggregate680 kg/m3, net duty of water210 kg/m3 and water reducer solid 3.6kg.

3. Research on study of mix proportion and bending performance of alkali-resistant glass fibre enhanced seawater coral aggregate concrete

Mix proportion of lightweight aggregate concrete for test is shown in table 2.

Table 2. Coralaggregate concrete mix proportion

Cement /($kg•m^{-3}$)	Net duty of water/($kg•m^{-3}$)	Coarse aggregate/($kg•m^{-3}$)	Fine aggregate /($kg•m^{-3}$)	Water cement ratio /($kg•m^{-3}$)	Volume sand ratio/%	Water reducer /($kg•m^{-3}$)
450	210	680	660	0.47	43	3.6

150mm×150mm×150mm was adopted as the specimen size for measuring coral aggregate compressive strength. Standard specification specimen of 150mm×150mm×550mm was adopted as the specimen size for measuring the breaking strength. Compressive and bending strength and tensile splitting strength were measured respectively in accordance with the national provisions. Three-point bending test was carried out on the universal testing machine (span of 450mm). The bending performance of alkali-resistant glass fibre enhanced seawater coral aggregate concrete is studied. The influence law of different alkali-resistant glass fibre dosages on concrete compression tensile strengthand bending toughness was obtained.

In the experiment, 7d and 28dcompressive strength as well as 28dbreaking strength and tensile splitting strength of seawater coral aggregate concrete were tested when the volumetric fraction of alkali-resistant glass fibre was respectively 0, 0.50%, 1.00%, 1.50% and 2.00%. Alkali-resistant glass fibre volumetric fractionis abscissa, and compressive strength, breaking strength and tensile splitting strength are abscissa after test. It is concluded that the fiber mixing can lower compressive strength of alkali-resistant glass fibre enhanced seawater coral aggregate concrete to certain extent. Tensile splitting strength trend is decreased after increase with the increase of fiber dosage. When the glass fibre dosage is 1.5%, the tensile splitting strength reaches the maximum. The breaking strength and flexural compression ratio are increased greatly with the increase of fiber dosage. It is obvious that the mixing of alkali-resistant glass fibre can significantly improve the toughness and flexture strength of seawater coral aggregate concrete.

4. Significance of studying alkali-resistant glass fibre enhanced seawater coral aggregate concrete

The novel building material- alkali-resistant glass fibre enhanced coral aggregate concrete is studied in the paper. Coral reefis adopted as raw material. Coral reefs are processed. The obtained fragments in larger size are used as ‘stones’ in concrete raw materials. The crushed slags with smaller particle size are regarded as ‘sand’. They are manufactured into alkali-resistant glass fibre enhanced seawater coral aggregate concrete with ‘seawater’ mixed according to the south China sea seawater composition, ordinary cement and alkali-resistant glass fibre. The enhanced coral aggregate concrete not only can solve the problem of coral aggregate concrete itself, but also can solve the corrosion problem of common reinforcing material. In addition, the dead weight is small. Cement in the required raw materials should be transported in land only. Island resources are utilized fully, thereby saving construction cost and shortening the construction period. It has important significance for the development and construction of ocean island.

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References

[1] Sun Xiao, Wei Zhuobin, Gao Yi. Experimental study onmix proportion of seawater mixed coral aggregate concrete. Sichuan Architecture, 2016, 36 (02): 204-206.
[2] Wu Peng, Li Lu. Research onglass fibre enhanced light aggregate concrete mechanical property and fatigue damage. Concrete and Cement Products, 2014, 9 (09): 52-55.
[3] Li Lin, Zhao Yanlin, Lu Haibo, et al. Research on the influence factors of coral aggregate concrete mechanical property. Fujian Building Materials, 2011 (01): 10-11.

[4] Pan Bozhou. Experiment study on coral aggregate concrete mix proportion design and basic mechanical property. Wuhan: Naval Engineering University, 2014.
[5] Cao Gang. Experimental study on high strength light aggregate concrete. Xi'an: Northwest Polytechnic University, 2004.
[6] Wang Hailong, Shen Xiangdong. Experimental study on early mechanical property of light aggregate concrete. Silicate Bulletin, 2008, 27 (5): 1018-1022.
[7] Chen Yan. Research on design and performance of high strength light aggregate concrete mix proportion. Changchun: Jilin University, 2007.